

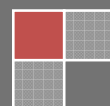
2009

# *ELECTRONIC THEODOLITE SERVICE MANUAL*

SOUTH SURVEYING & MAPPING INSTRUMENT  
CO., LTD.



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## The structure of Electronic Theodolite

The ET of this series includes telescope, vertical encoder disk, horizontal encoder disk, electronic reading system, plate level, vertical axis, horizontal axis, horizontal clamp and tangent screw, vertical clamp and tangent screw, optical plummet, base and so on.

### A. Telescope Unit

The telescope unit includes three parts: eyepiece, object lens and focuser. It has outside-focusing-style which demands cozy and flexible rotation with no block and no sway. The eyepiece unit consists of eyepiece and **reticle unit**.

### B. Horizontal Axis Unit

The horizontal axis unit includes horizontal axis, its axletree and other sections. The horizontal axis should be rotated flexible, at the same time, it should be vertical to the vertical axis and position is unchangeable in axletree during rotate.

Vertical encoder disk is on the left of horizontal axis, the telescope and cursory collimator are on the middle of it. Sliding ring is on the right of horizontal axis.

In structurally, the vertical encoder disk should be assembly in correct position according following requirements:

- a. the encoder disk centre and the horizontal axis centre must be positioned at the same point.
- b. the reticle board of the vertical encoder disk must be perpendicular to the horizontal axis.

### C. Handgrip Unit

The handgrip unit, convenient for carrying or laying, is fixed on the left and right brackets with two setscrews.

### D. Sighting Collimator Unit

The sighting collimator unit, for collimating the target at the beginning step, are fixed on the connection of the telescope and middle of the horizontal axis. On the side of the object lens, there will be plane glass of “+” or “△” type; while on the other side (the side of eyepiece), there will be a magnifier through which “△” or “+” can be seen distinctly. Sighting collimator unit and the EDM axis must be coaxial.

### E. Vertical Axis Unit

The vertical axis unit consists of vertical axis, sheath axis, horizontal encoder disk, CCD bracket, low cover etc. This unit enables telescope, alidade and CCD photoelectric sensor to rotate horizontally in a vertical way. Vertical axis unit is a half-athletic cylinder.

### F. Vertical Clamp and Tangent Unit

It consists of clamp hand wheel, tangent hand wheel, clamp ring, clamp and tangent sheath, clamp and tangent filar pole, versatile sheath, etc.

The clamp unit, clamped by the clamp ring, clamp block, and cam block, rotates around the clamp and tangent filar pole and thus the clamp and tangent hand wheel works on the same axis.

**G. Horizontal Clamp and Tangent Unit**

Its case is just the same as that of vertical clamp and tangent unit. Pass it over here.

**H. Level Unit****a. Plate level**

The plate level with protective glass is installed on the alidade bracket and is vertical to adjustment vertical axis unit. The level is obturated with plaster in the metal tube. There is a setscrew on the right of the metal base with an adjusting screw which can make the left of the level rise or fall so as to adjust the plate level axis vertical to vertical axis.

**b. Circular level**

As a primary leveling one, bubble of circular plate can be adjusted to move to the center directly after plate level is well adjusted.

**I. Battery Box**

The battery box of ET consists of four nickel-hydrogen batteries, which normal voltage value is between 5.5V and 7V.

**J. Optical Plummet**

The focusing device of optical plummet is similar to the inside focusing telescope. Rotate focusing hand wheel of eyepiece, make reticle in focus, this process is called focusing for reticle board. Rotate focusing hand wheel in order to make the imaging of target point that is on the reticle board is in focus, too. In addition, reticle is required to go through the prism on structure, and should go through the center of the object lens after turning.

**K. Display Unit**

The display unit consists of display board, display driver, IC parallel interface, etc.

When being output from parallel interface, characters are sent to computer which exports signals and transmits instructions to display driver. After receiving address route and external synchronic signal, display driver acts together with clock SCL, reading in data from computer and IC, then shows with character.

**L. CCD**

CCD photoelectric sensor consists of infrared light-emitting diodes, CCD photoelectric receiver and other parts. The light signal form tube emit to the encoder disk plated with transparent and opaque stripe. According to the working principle of encoder disk signal, it measure the angle value

**M. Base and Leveling Screw**

Unlock the setscrew of the three-jaw base, discharge alidade and base. Place the instrument and base on the worktable, then loosen the cap of screw, rotate the nut clockwise, turn the base upside down, loosen the three brads on the trigonal soleplate with screwdriver to separate the leveling screws from base and separate the base from the trigonal soleplate. Hereto, the spare parts such as leveling screw can be cleaned and oiled.

## N. Plumb and Tilt Sensor Unit

The sensor consists of electronic bubble and measurement circuit, which is fixed on the right of main body by two setscrews. It must ensure the reading of vertical disk is 90° and the plate level is centered when the collimating axis stays horizontal.

### Instrument Disassembly Procedure

#### Preparations:

Prepare screwdriver, nipper, forceps, Hexagon wrench, alcohol etc and clean up hands.

Prepare a tray or other container to place the offloaded screws in case of lost.

If it is necessary record the information of the color and location of every part in order to prevent damaging the instrument due to false reassemble.

Set the instrument on a suitable table to work for avoiding parts lost and instrument damage.

#### Brief introduction:

This chapter introduce the normal entire disassembly process of absolute encoder type electronic theodolite ET-02/ET-05 and the process comply the following steps. The assembly process is the same as the disassembly if there is not any special note. Please refer to the related information in this chapter if some parts need to be maintained or replaced. Any part should be fixed with fixing painting on the setscrews after reassemble except the cover parts such as vertical disk cover, EDM cover and slip ring cover. Though some parts would be updated when manufacturing the instruction in this chapter is still applied to it. If there are parts unconformed to this handbook, disassemble them according to the actual situation.

#### Disassembly procedure:

##### Step 1: Left cover

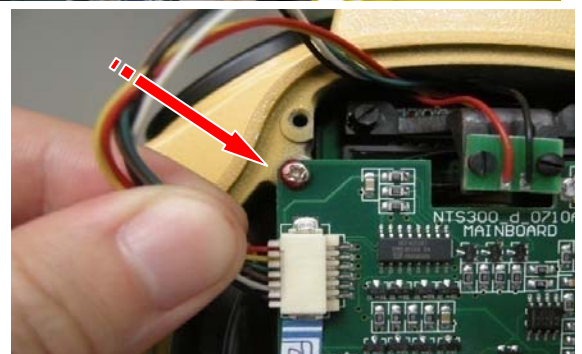
Remove the 6 screws and take off the left cover gently

Take care of the connecting wire between the inside of the left cover and the beep after opening the left cover, then remove the left cover.

##### Step 2: angle main board

Refer to step 1, take off the left cover and remove 4 screws which fix the angle main board.

Unplug every **connector** from main board carefully and record their type and location for reassemble. Take care of the removed angle main board.



### 3. LCD plate

Remove the 4 screws fixing the display plate and then open the LCD plate lightly.

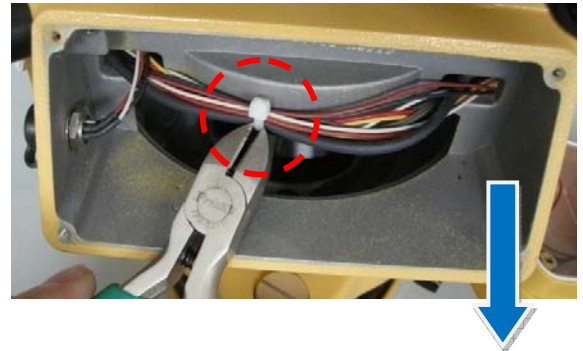


Take out the LCD and keep it carefully.



### 4 Right cover

Refer to step 3, take off the LCD plate on the left of right cover. Snip the string noted in the red circle in picture. Take care do not damage the wire.



Remove the 6 setscrews fixing the right cover and then open the right cover gently. Be care of the power wire on the inside of the right cover and do not drag it too hard to damage the power wire.



Draw out the power wire and then the right cover can be take off completely.



### Step 5: Vertical absolute encoder disk unit (left horizontal axis for short)

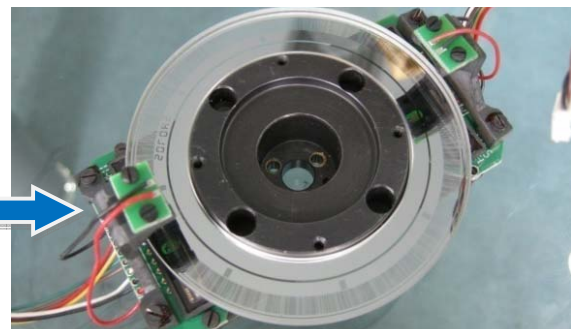
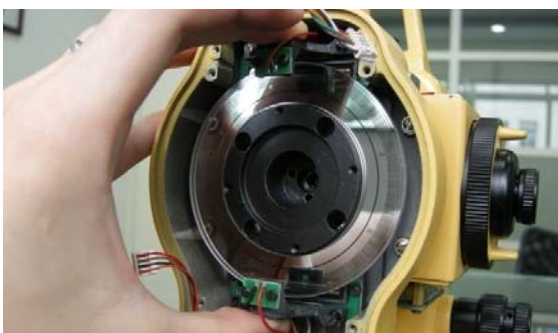
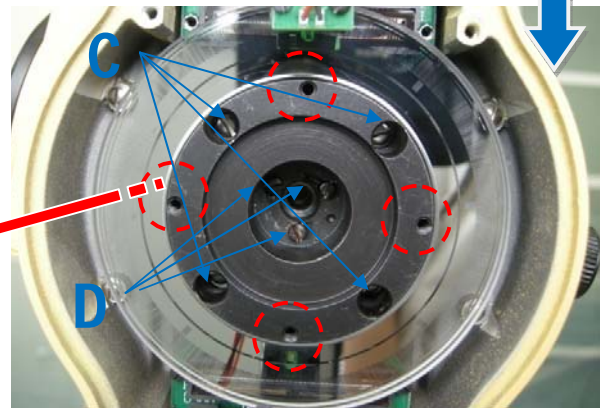
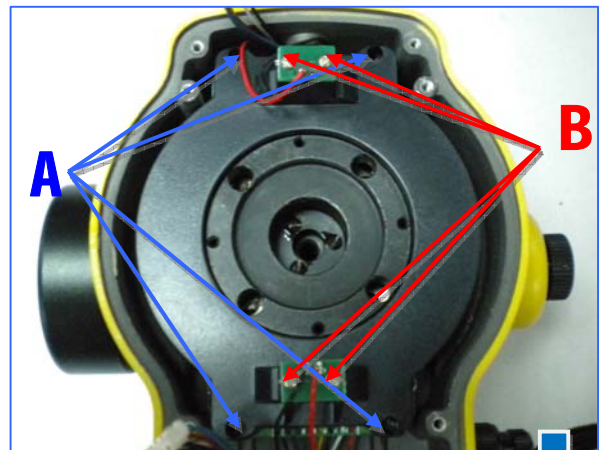
Refer to step 1 and 2, unload the **left** cover and angle main board. Refer to the picture, remove the 4 dust-proof setscrews on A points and 4 setscrews fixing CCD laser tube on B points.

As shown in the picture, remove 4 setscrews of left horizontal unit on C points and other 3 on D points. Pay attention that rotating telescope to aim the screw holes of the disk bracket to the 4 screws on C points. The screws on C are white ones with round head

The red dotted line circles indicate that there are 4 black base setscrews with plate head under the disk. Do not disassemble these 4 screws when remove the left horizontal axis unit



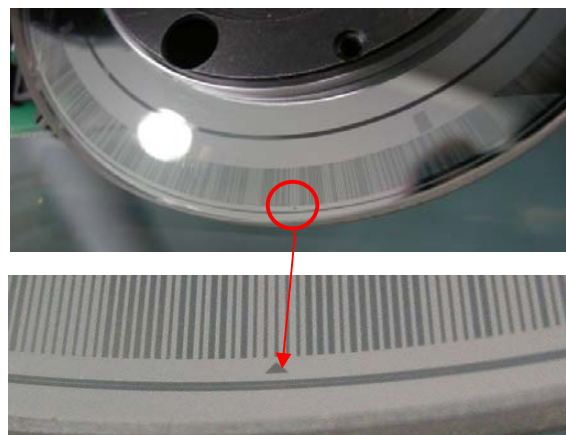
Pinch the two CCD brackets, rotate outward to take off the whole left horizontal axis unit. Take care of the absolute encoder disk for it made by glass and easy to be damaged. The axis system connecting it with the telescope is also very precise. So the disassemble procedure must be very careful under the safety situation. If the axis is hard to be removed, please send it back to the factory. Do not enforce to take it out to avoid damaging axis or even blocking. Save it properly after being removed.



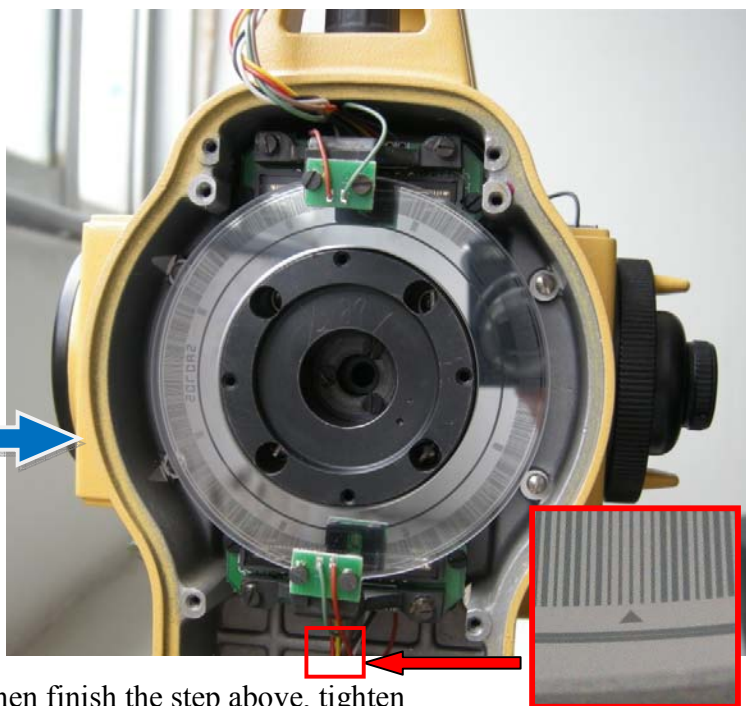
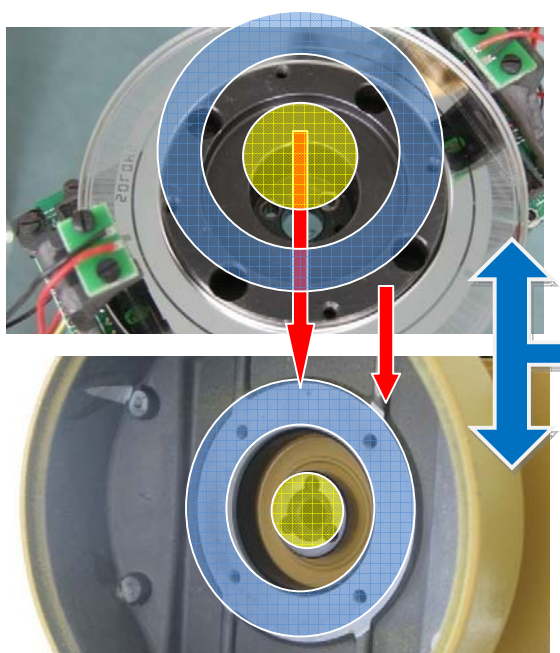
assembly notice: the left horizontal axis should be installed according the following principle.

If replacing CCD unit is needed, install two vertical CCD units first.

then find out the triangle start mark on the encoder disk edge(circled in the picture). This mark point at the position of the start code of the encoder.



As shown in the picture, keep the telescope left status when final assemble. Gently rotate the disk though the left horizontal axis to connect it with the telescope. One hand fix the telescope and the other hand rotate the disk gently and aim at the screw holes between the body and telescope. Be sure that the triangle marked on the disk must stay nearby the lower vertical CCD. This is very important. If the position of the disk is not right the instrument will display false vertical angle information.

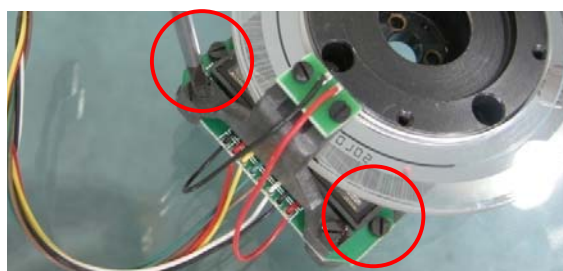


When finish the step above, tighten setscrews and do not forget to reassemble some parts such as

gasket.

### Step 6: Vertical CCD Unit

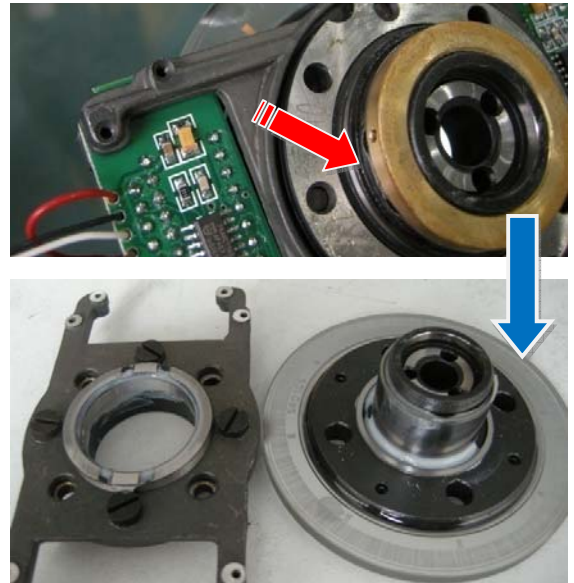
Refer to step 1, 2 and 5, take off the left cover, angle main board and vertical absolute encoder disk, then remove the 4 setscrews circled in the picture. Take off the vertical CCD unit and remove the other CCD unit by the same method. Keep CCD properly.



### Step 7: Left horizontal axis sheath (vertical CCD unit bracket)

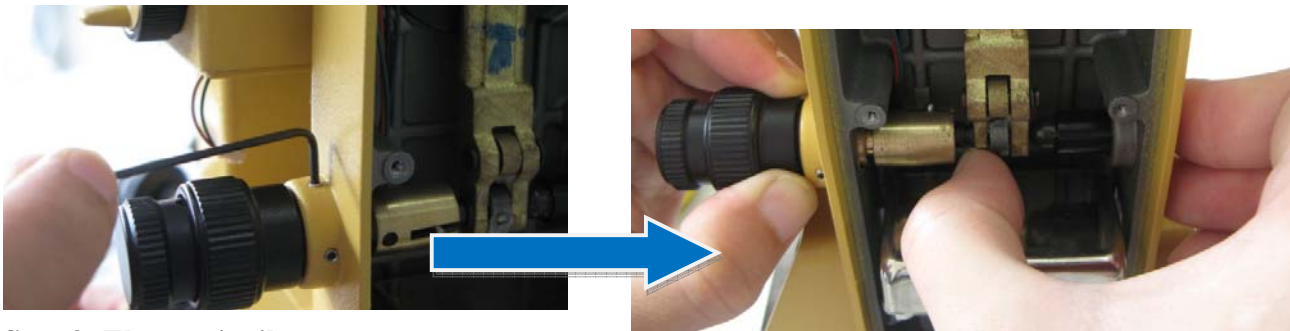
refer to step 1, 2, 5 and 6, remove left cover, angle main board, vertical absolute encoder disk and vertical CCD unit, then invert the disk unit, there is a copper horizontal axis, use a round clamp to remove the fix cover.

Hold the left horizontal axis sheath in one hand and hold the absolute vertical encoder disk in the other hand, then take the disk out of the axis. Keep these two parts properly.



### Step 8: Vertical clamp and tangent handwheel

Refer to step 4, remove the right cover and then loosen(not remove) the 2 vertical clamp and tangent fix screws by hexagon wrench, the right thumb press the bottom of the vertical clamp rod, the left hand drag the vertical clamp and tangent handwheel gently.



### Step 9: Electronic tilt sensor

Refer to step 1,3,4, remove the left cover and unplug the electronic tilt sensor plug, remove the LCD plate on the left of right cover then cut the string. Drag the connecting wire and open the right cover. Then remove the two setscrews shown in the picture.

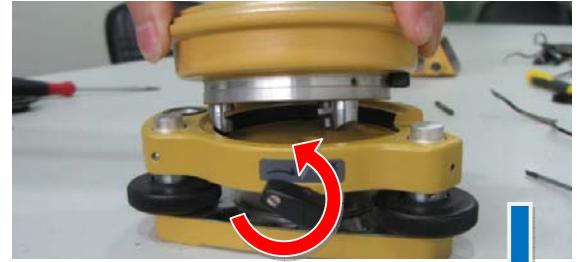
### Step 10: Horizontal clamp and tangent screw

Refer to step 3, remove the LCD plate on the left of right cover then loosen the 2 horizontal clamp and tangent fix screws by hexangular spanner. The right hand thumb press the left end of the horizontal brake rod and drag the horizontal clamp and tangent screw gently by left hand.

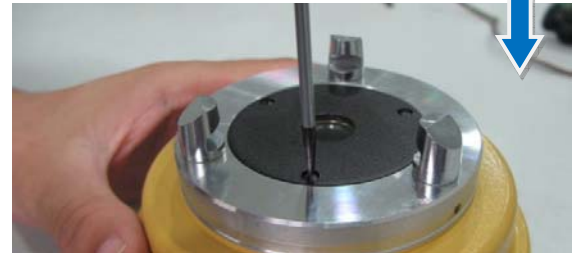


### Step 11: Horizontal absolute encoder disk unit and vertical axis unit(Lower base unit for short)

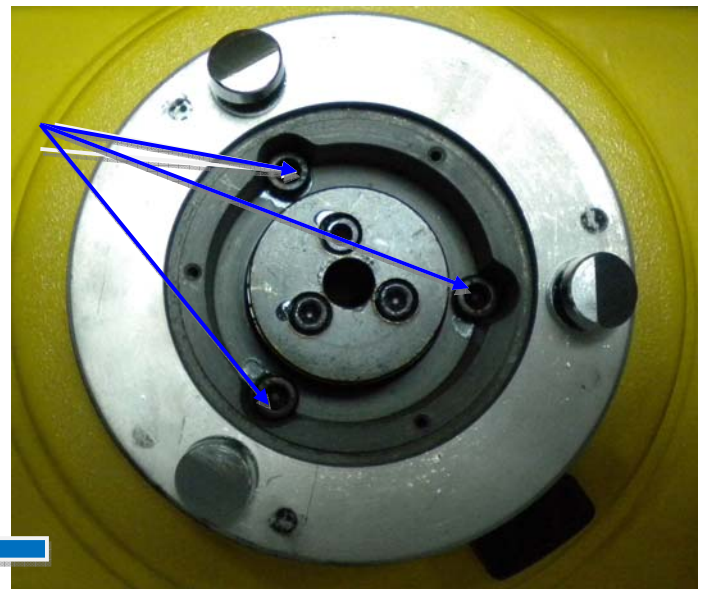
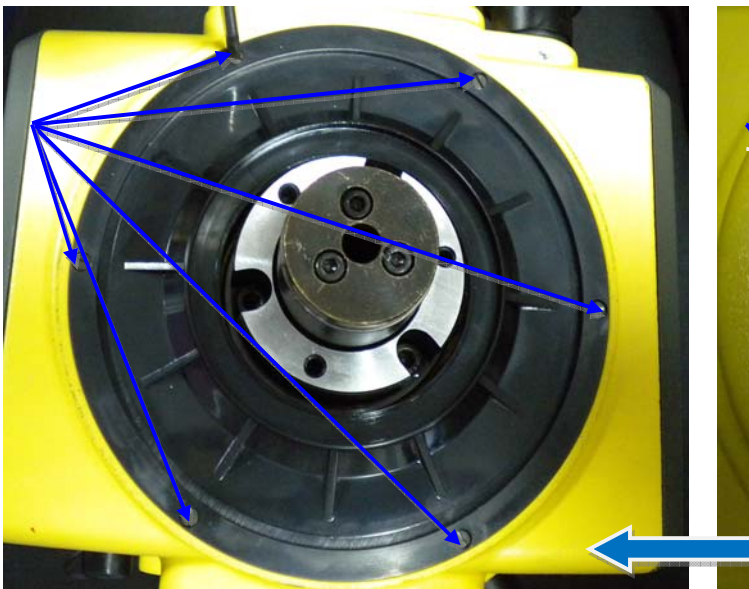
According to the direction of red arrow shown in the picture, loosen the base locker to separate the base.



Invert the whole lower base unit and remove the 3 lower base cover-protection screws, then take off the lower base cover.



Remove the 3 setscrews of the lower base cover by hexangular spanner, then the horizontal disk dust-proof cover can be seen, take off the dust-proof cover after remove the 6 setscrews.



Refer to the step 1,2,3,4 and 10, remove left cover, angle main board, 2 LCD plate and right cover, cut the wire string then remove the horizontal tangent handwheel.

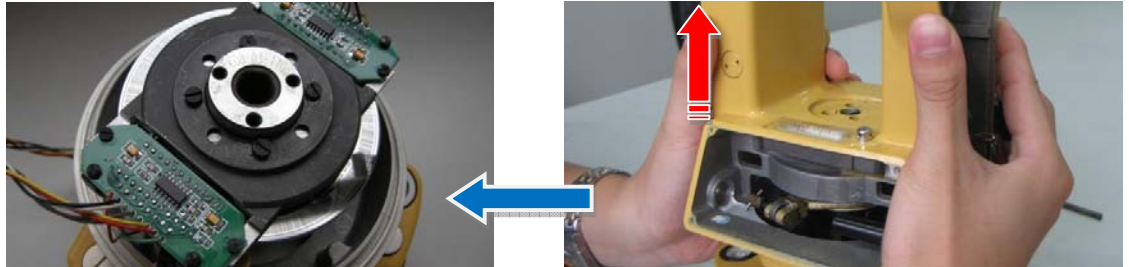


Remove the 4 center rubber mats by screw driver

Remove the 4 vertical axis setscrews by hexanglar spanner.

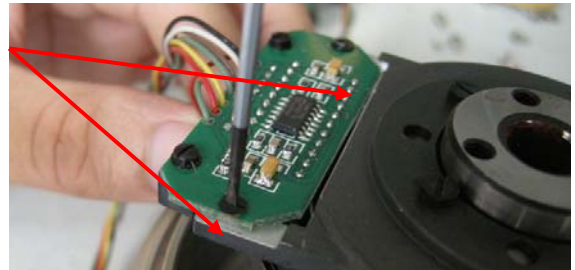


Hold the main body tightly by two hands toward the red arrow direction show in the picture. Take care avoid the horizontal clamp ring and draw two units of connecting wire of the horizontal CCD. Then the upper body separated from the lower base unit. Pay attention when lift the body to prevent damaging the horizontal CCD unit or horizontal absolute encoder disk.



### Step 12: Horizontal CCD Unit

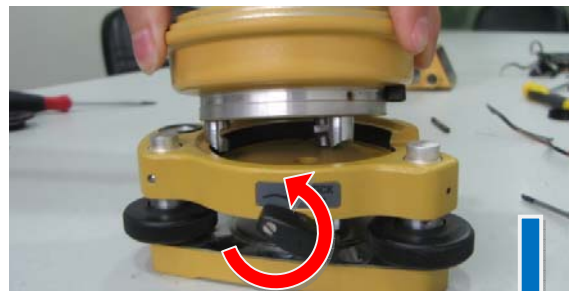
Refer to the step 11, separate the upper part of the main body from the horizontal absolute encoder disk unit. Remove the 2 horizontal CCD setscrews, then remove the horizontal CCD unit carefully. Take off the other horizontal CCD unit in the same way. The parts removed should be saved properly.



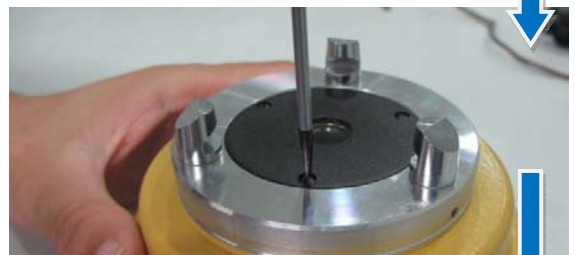
### Step 13: Vertical axis unit

Refer to the step 11 and 12, separate the upper part of the main body from the lower base unit. As shown in the picture, loosen the base locker around the red arrow direction to

separate the base.



Invert the whole lower base unit, remove the 3 lower base cover prevention screws and then remove the cover, take care to avoid damaging the horizontal absolute encoder disk when invert it.



There is a copper vertical axis fix cover under the lower base cover, remove the vertical axis fix cover by hexagonal spanner.



Keep the bottom of the lower base upward. Uplift the lower base gently along the direction of the red arrow, then the lower base(it contains horizontal absolute encoder disk) will be separated from the vertical axis.

Note: in order to prevent scattering the vertical axis ball bearings, the bottom of the lower base must be kept upward. The vertical ball bearings of every ET are assembled as a whole set. So if any ball is broken **or loss** it need to be replaced with a new whole set. So instantly nip all balls into a safety container to avoid any accident.



#### Step 14: Plate vial

Totally loosen the adjusting screw by adjusting pin.

Refer to step 3, remove the LCD plate of right cover, remove the setscrew of the plate vial, then remove the plate vial.



#### Step 15: Optical plummet

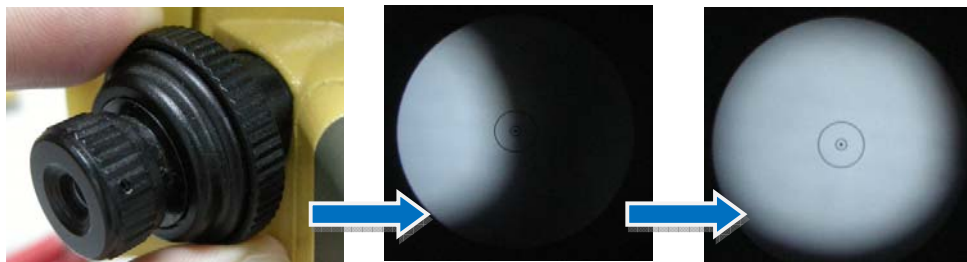
Refer to step 3, remove the LCD plate on the left of the right cover. Then loosen the 2 fix screws of optical plummet by hexangular spanner.

Drag the optical plummet gently and save it properly.

Pay attention when assembly: put the ET on the tripod without leveling. Insert the optical plummet into the main body. Do not tighten the fix screws, then observe the image form it.

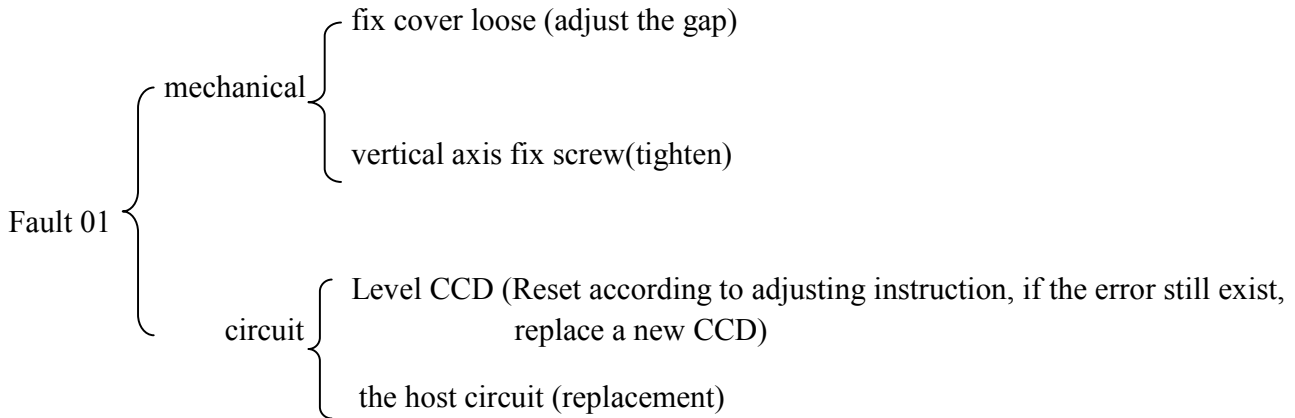


Gently rotate the optical plummet until it display complete image. Then tighten the 2 fix screws.



## Maintenance of ET faults

### The maintenance of Fault 01--- Fault 07



Fault 02: rotate too fast in vertical direction (protection error)

Fault 03: rotate too fast in horizontal direction (protection error)

Fault 04: Vertical CCD sensor (the same as fault 07)

A, week signal (readjusting signal)

B, encoder disk dirty (clean the disk)

C, CCD malfunction or the surface of CCD dirty (clean it or replace it)

D, sunlight leak into the inner-instrument though the cover gap

E, main board malfunction (replace a new one)

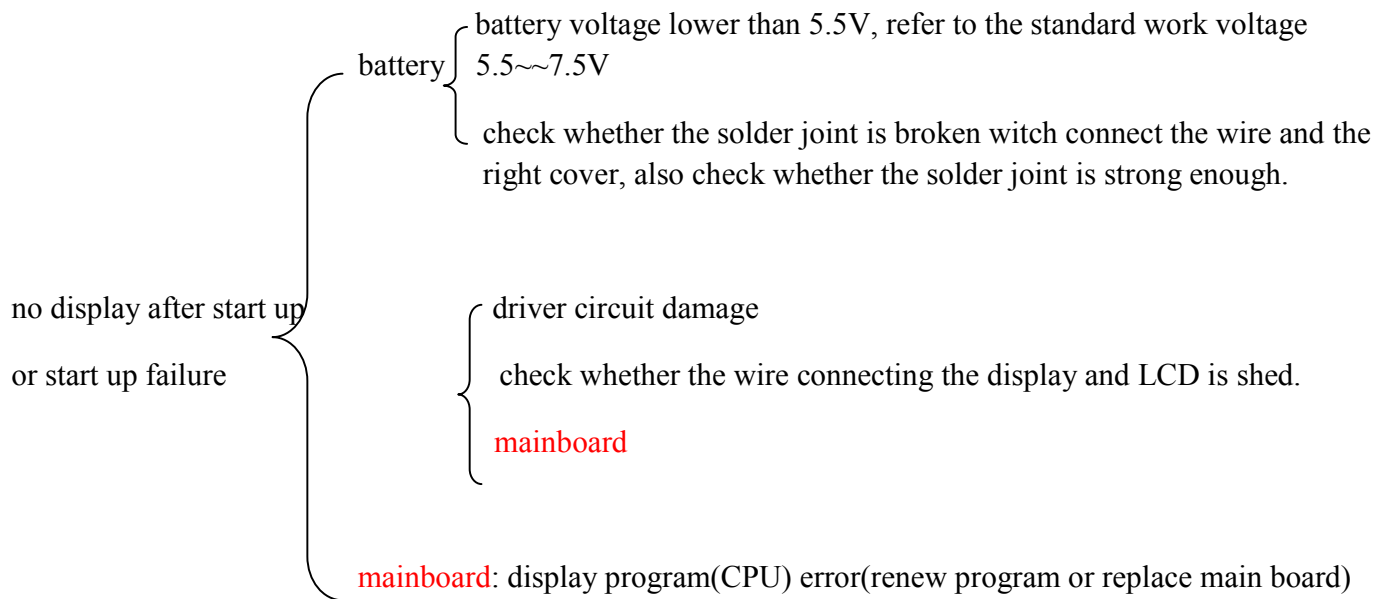
Fault 05: Horizontal CCD sensor (the same as fault 06)

A, week signal (readjusting signal)

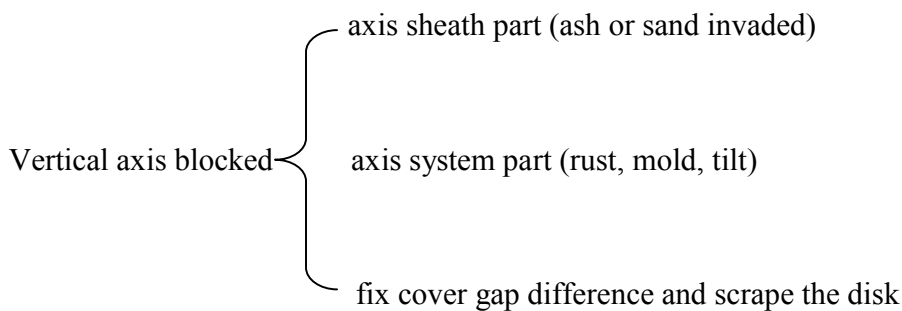
B, encoder disk dirty (clean the disk)

C, CCD malfunction or the surface of CCD dirty (clean it or replace it)

D, sunlight leak into the inner-instrument though the cover gap



### The Axis Blocked



### Adjusting steps:

Do not rotate the alidade forcibly when you find the vertical axis tweak tightly, if not, the consequence will turn out to be worse

1. Remove the vertical axis unit according to the step 13 of the theodolite disassembly procedure.
2. Clean the axis shaft and axis sheath with cotton.



3. Add appropriate amount of **abrasive paste** in the bottom of the axis shaft (as shown in the figure)



4. Sets the grinding stick in the grinded axis shaft, rotate the axis shaft with appropriate force. Do it carefully. In general, the rotation could be a few when there is not much deviation.



5. Grinding finished, clean the **abrasive paste** with cleaning solution. Be aware that it must be cleaned.

6. Grind the axis sheath.



7. Grind the axis sheath with the grinding stick which has appropriate amount of **abrasive paste** on the surface.

8. Grinding finished, clean the axis sheath with cleaning solution.



9. Mount the balls bearing back, and reassemble the vertical axis, rotate the vertical axis until it is comfortable.

10. If still feel tight, repeat the steps above.

Horizontal Axis Blocking { The position between axis shaft and axis sheath change  
The axis gets rusted, moldy, or mal-posed.

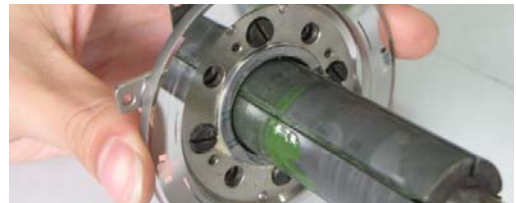
### Adjusting steps:

Do not rotate **telescope** forcibly when the horizontal axis was blocked, if not, this may cause more serious consequences.

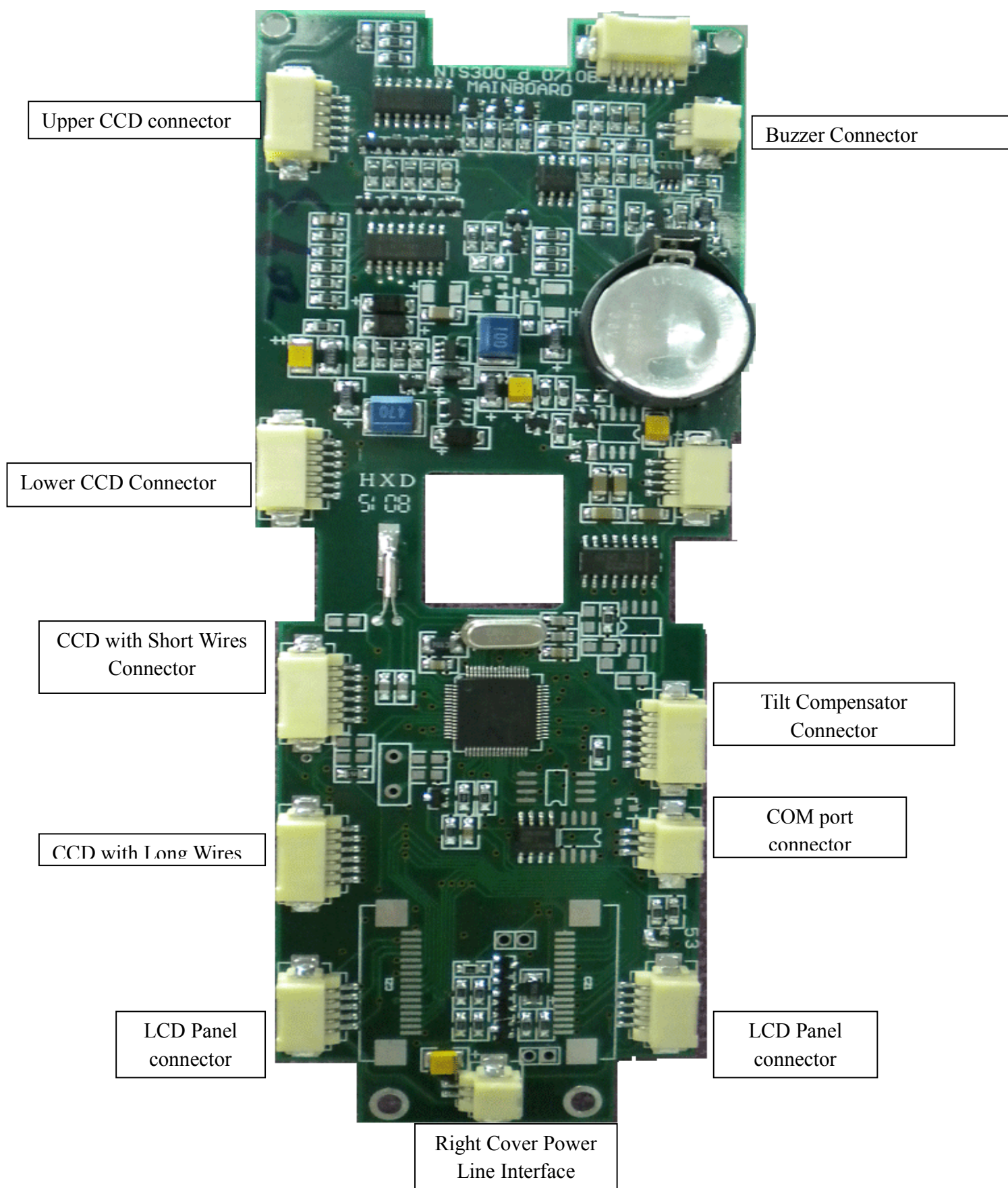
1. Remove the horizontal axis unit and disassemble the encoder disk and left horizontal axis sheath according to the step 7 of the theodolite disassembly procedure



2. Clean the axis shaft and axis sheath with cotton.
3. Add appropriate amount of **abrasive paste** in the bottom of the axis shaft (as shown in the figure)
4. Set the grinding tool in the grinded axis shaft, and then rotate the grinding stick with appropriate force. Do it carefully. In general, the rotation could be a few when there is not much deviation.
5. Grinding finished, clean the **abrasive paste** with cleaning solution. Be aware that it must be cleaned.
6. Grind the axis sheath.
7. Grind the axis sheath with the grinding stick which has appropriate amount of **abrasive paste** on the surface.
8. Grinding finished, clean the **abrasive paste** with cleaning solution. Be aware that it must be cleaned.
9. If still feel tight, repeat the procedures above.



## Main board of the Angular Measurement



# CHECK AND ADJUSTMENT

## Preparation

Before the adjustment you should prepare the tools such as screwdrivers, correction pins, varnish and hexagon wrenches, then put the instrument on the collimator and you had better wash your hands before the adjustment.

## Introduction

In this **chapter**, it introduces the adjustment procedure of theodolite ET-02/ET-05. The whole procedure will operate on the collimator according to the following steps, the operation in the open air or other place will not be described in this chapter. Be aware that, except the adjustment of optical plummet, other adjustments must be in accordant to the following steps. Disarrange the steps will not assure the parameter of the instrument will conform to the standard specification.

## Calibration

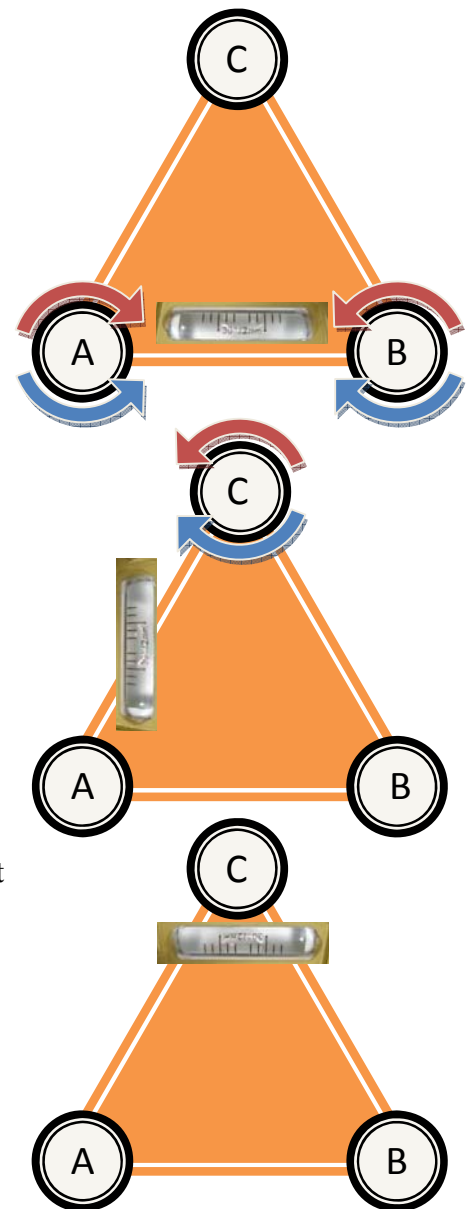
### 1. Plate Vial

Rotate instrument, make plate level parallel with line between two leveling screws A and B, then adjust two leveling screws A and B in one direction, clockwise or counter-clockwise, to make plate bubble centered

Turn the instrument for 90°, make the plate bubble vertical to the two leveling screws A and B. Adjust the third leveling screw C, and make the plate bubble centered. Repeat the steps till to the bubble in center in both positions.

### B

Rotate instrument around vertical axis with a 180°. If the plate bubble is not centered, the plate vial needs to be adjusted. The working principle is that, as shown in the red region, adjust the adjusting screws with correction pin, and make plate bubble to move half of the offset back. Repeat the steps above to check the adjustment until the plate bubble is centered.



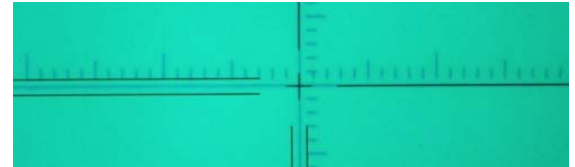
## 2. Circular Vial

After adjustment on the Plate Vial, circular bubble should be centered too. If not, adjust three adjusting screws with correction pin to make the circular bubble centered. The working principle is that, first loosen two screws opposite with bubble deflective direction, and then tweak tightly the third screw.

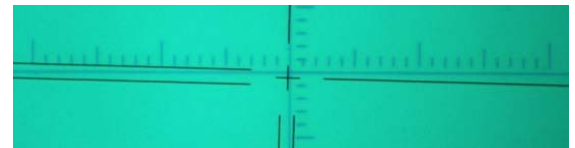


## 3. Eyepiece Reticle

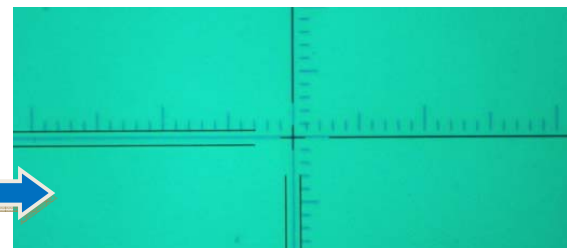
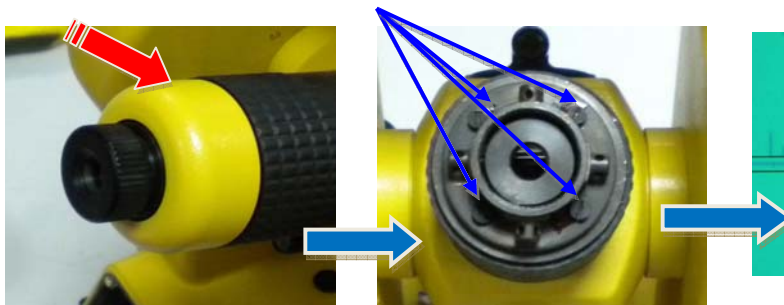
Rotate the telescope and aim the collimator, observe the reticle coincide with the far crosshairs of the collimator or not. If not, it needs to be adjusted. All the following adjustments base on the correct collimator.



As shown in the figure, the reticle is declination. So it needs to be adjusted.

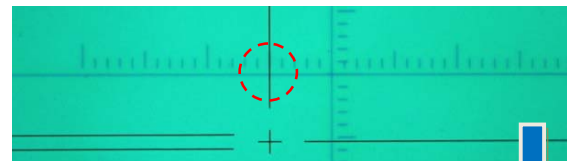


As shown in the figure, first disassemble the Eyepiece cover, and then loosen four screws which fix the base of reticle board, aim the crosshairs of collimator and rotate the reticle board lightly. When the reticle board coincides with the crosshairs, tighten four screws. The adjustment completes.



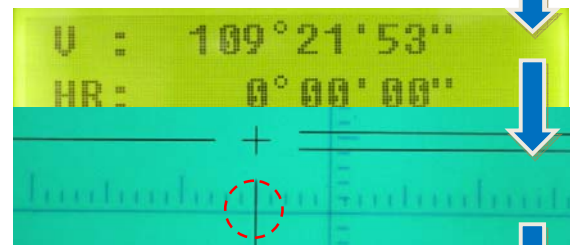
## 4. 2C (Perpendicularity between Sight Line and Horizontal Axis)

As shown in the figure, rotate the instrument and aim the far crosshairs at a certain horizontal line of the collimator. Note down the value. And then tighten the horizontal clamp.



Press "OSET" twice to reset the horizontal angle.

Reverse the telescope and aim at the same position (as shown in the figure), and tighten the tangent screw.



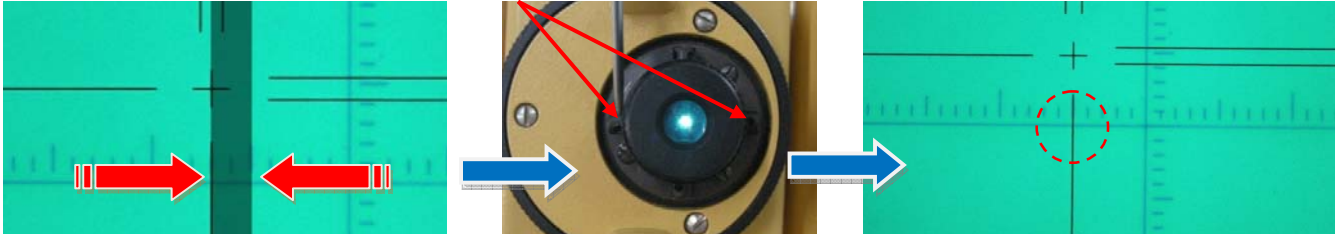
Note down the horizontal angle value, use the formula " $HR - 180^\circ = 2C$ " to calculate the value of 2C, which should be within  $\pm 8''$ . As shown in the figure, the value of HR is  $180^\circ 00' 40''$  and the 2C error is  $+40''$  so that the instrument should be adjusted.



Adjust the horizontal clamp and tangent screw to make the horizontal angle value to half of the difference as  $180^{\circ}00'20''$ .



Then sight at the horizontal collimator, and observe how much the deviation, which is shown in the gray field, is from the graduation. Take off the reticle cover, and adjust the left and right adjusting screws to make the vertical reticle back to the graduation. The working principle is that we should loosen an adjusting screw firstly, and then tighten another screw.



After the adjustment, check the 2C error again. If it does not conform to the requirement, please repeat the adjustment above.

## 5. High-low Difference

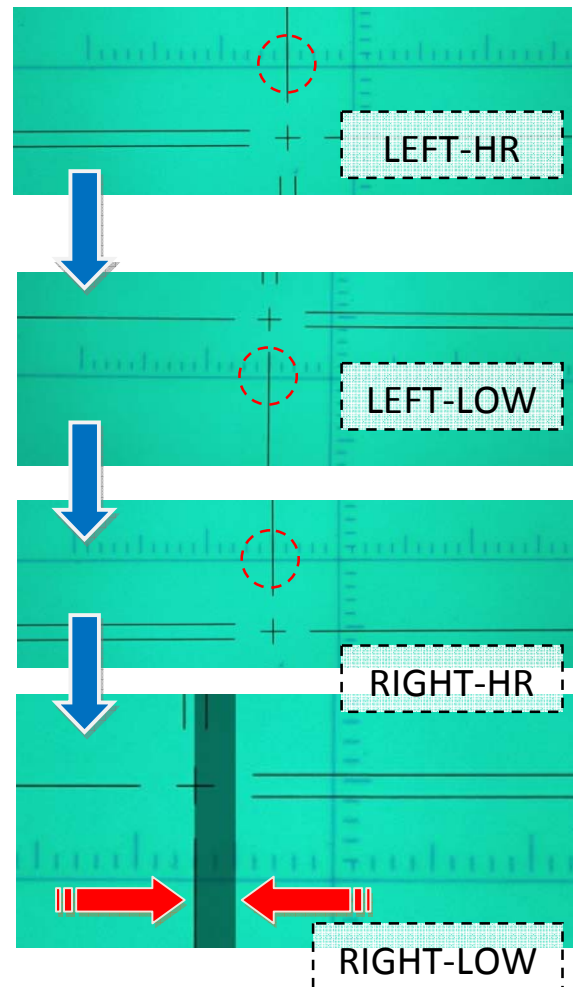
Turn the instrument to circle left and aim crosshairs at a certain graduation in the collimator, note down the corresponding grid value on the horizontal crosshairs. Then tighten the horizontal clamp.

Loosen the vertical clamp, rotate the telescope and sight at the lower collimator, note down the corresponding grid value on the vertical crosshairs. Be aware that the corresponding grid value between the vertical crosshairs and horizontal crosshairs may be different.

Rotate the instrument to circle right, sight the vertical crosshairs at the former value and tighten the vertical clamp.

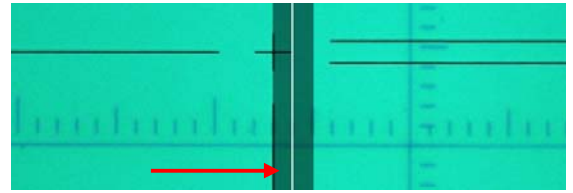
Loosen the vertical clamp; rotate the instrument and sight at the low collimator. As shown in the figure, compare two corresponding grid values and note down whether the high-low difference value is within  $10''$  which is one third of the mini graduation. Otherwise, it needs to be adjusted. As shown in the figure, the difference, which exceeds the permissible range, is over two mini graduations

Disassemble four center covers according to the step 11 of the theodolite disassembly procedure. Use allen key to adjust four



adjusting screws to narrow the high-low difference. Be aware that adjust to half of the error.

As shown in the figure, adjust four clamping screws to move the vertical crosshairs to the white line, which is the half of the high-low difference.



After the adjustment, tighten four adjusting screws with varnish, the adjusting screws must be in the tightening state. Otherwise, instability of the instrument will affect the normal usage. Be aware that, after the adjustment of high-low difference, the plate vial and plumb line needs to be readjusted.

## 6. Compensators

Be aware that the plate vial has been adjusted and the theodolite is on the collimator

Press “POWER ON” and “V/%” to start the instrument. When heard the three times “beep”, press “L/R” five times, “HOLD” five times to enter the compensator mode.

Frequency value of compensator is showed on the first line, and this F value should be within the range of  $\pm 60$ . As shown in the figure, the value is -2302, which is over  $\pm 60$ , it needs to be adjusted. According to the step 4 of the theodolite disassembly procedure, disassemble right cover and mount the battery. Screw off two clamping screws. Adjust the theodolite to circle left and power on, and then enter the compensator mode.



Use the screwdriver to tap two sides of compensator according to the red arrow shown in the figure, figure out the difference of the F value.



As shown in the figure, tag the compensator until the F value is within the range of  $\pm 60$ , and then tightens two clamping screws.



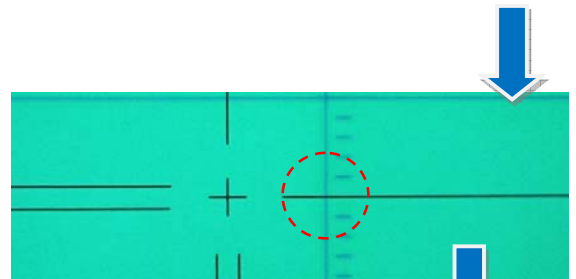
After the above steps, turn the theodolite to the circle right to figure out whether the F value is within  $\pm 60$ . If yes, press FUNC twice to complete the adjustment. As it shown in figure, the coefficient of compensator is 3.97 and the temperature coefficient of compensator value is 0.2 which expresses that it is not necessary to be adjusted.



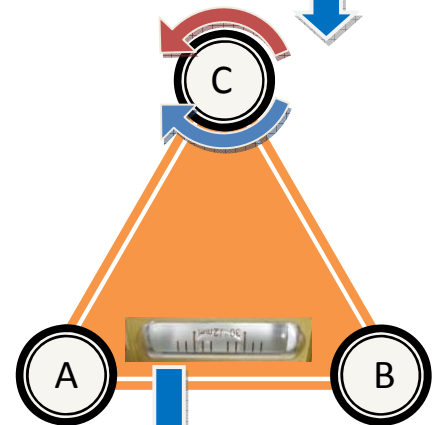
If the F value is over  $\pm 60$ , we have to calculate and reset coefficient of compensator. As shown in the figure, F value is 175 which are over  $\pm 60$ .



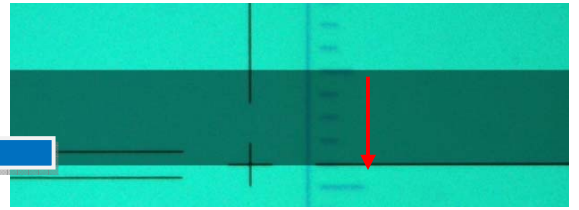
Return the theodolite to circle left and aim at horizontal collimator. As shown in the figure, aim crosshairs at a certain graduation in vertical collimator, note down the corresponding grid value. Then tighten the vertical clamp.



Observe the horizontal crosshairs of the theodolite, then adjust the leveling hand wheel C to make the instrument go up 5 grids on the reticle, note down the F value (F1). As shown in the figure, F1 is 627.



Readjust the leveling hand wheel C 5 grids down from the reticle center, and note down the F value F2.



Calculate out the coefficient as:  $K = (|F1| + |F2|) / 300$ , for example,  $K = (627 + 554) / 300 = 3.93$ . Press "FUNC" to enter the compensator mode, and input the K value "3.93", after that, press "FUNC" to save.



After rectification, level the theodolite, and enter the angle measurement mode, aim the instrument at reticle center of the collimator, adjust the leveling hand wheel C to adjust the instrument 5 grid up and down from the reticle center. Observe the difference of the V value. If the difference is within  $10''$ , the calculation of K value is correct. Otherwise, repeat the steps above.

## 7. I angle (Vertical Angle)

Sight the instrument at a certain graduation on vertical crosshairs in horizontal collimator, and note down the vertical angle value

Note down the vertical angle value V1, as shown in the figure, V1 is  $90^{\circ}00'00''$ .

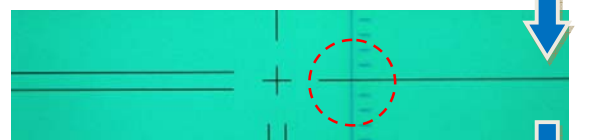
Reverse the instrument to circle right and sight it at the same position.

Note down the angle value V2. As shown in the figure, V2 is  $270^{\circ}00'50''$ . Then use the formula " $I = (V1 + V2 - 360^{\circ}) / 2$ " to calculate out the I angle which should be within the range of  $\pm 10$ . Otherwise, it is necessary to be adjusted.

As shown in the figure,  $I = (90^{\circ}00'00'' + 270^{\circ}00'50'' - 360^{\circ}) / 2 = 25 > \pm 10$ , the instrument needs to be adjusted.

Press "POWER ON" and "OSET" to enter the adjustment mode.

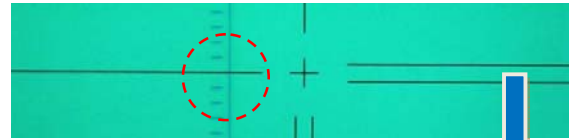
Turn the theodolite to circle left and aim at a certain graduation on the vertical crosshairs of the scale in horizontal collimator, note down the value.



Press “OSET” to enter the next step. Be aware that aiming at different graduation on the vertical crosshairs of the scale in horizontal collimator will affect the V value. As shown in the figure, value V is 90°00'00”.



Reverse the instrument to circle right and sight at the same graduation, note down the value.



Press “OSET” to save the adjustment and the screen will display the angle.



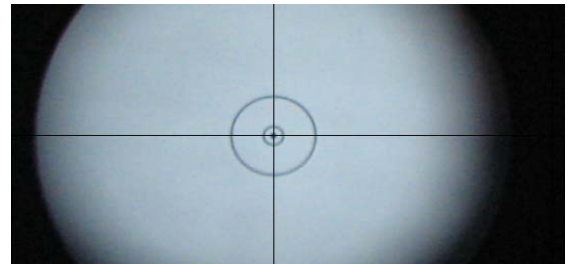
Be aware that, if the I Angle error is too much deviation, “E-20” will be displayed. Press “HOLD”, then “OSET”, and “HOLD” again for force alignment



After force alignment, the I Angle needs to be readjusted. If the I Angle doesn't meet the requirement, repeat the above steps for adjustment.

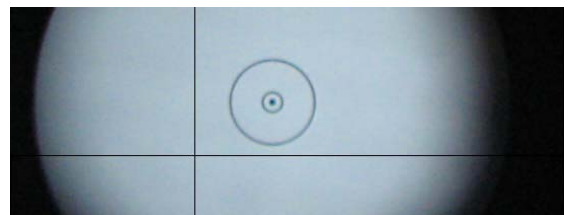
## 8. Optical Plummet

Set the instrument on a tripod and place a piece of white paper with two perpendicular lines on the ground. As shown in the figure, adjust the focus of the optical plummet and move the paper so that the intersection point of the lines on the paper comes to the center of the field of view.

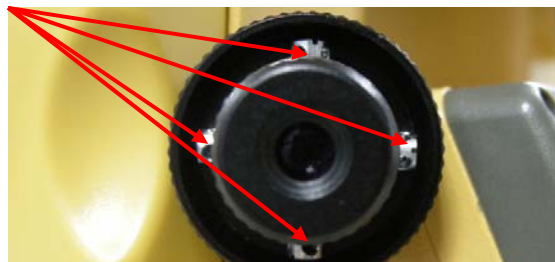


Rotate the instrument for 180° and observe whether the center mark position coincides with the intersection of the cross. If not, it is necessary to adjust.

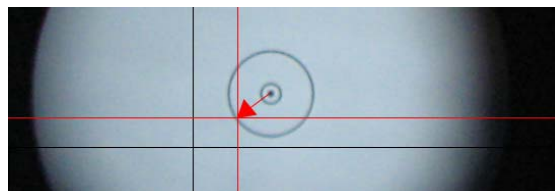
As shown in the figure, rotate the instrument for 180°, the center mark doesn't coincide with intersection which means it is necessary to adjust. The working principle is that, use the correction pin to adjust with 1/2 offset, and first loosen then tighten.



As shown in the figure, take optical plummet eyepiece cover off, use the correction pin to adjust the four adjusting screws.



As shown in the figure, make the center mark coincides with the intersection on the paper, that is to say, narrow half of the deviation between the centre and the intersection on the paper, then use leveling hand wheel to make the center mark coincides with the intersection.



After the above steps, retest the optical plummet. If the error still exists, repeat the steps above.

## TOOLS & CHEMICALS



Oscilloscope



Multimeter



Collimator



Screwdrivers



Pinchers



Allen Keys



Pliers



Grinding Sticks



Cotton



Lubricant



Alcohol



Green Grease